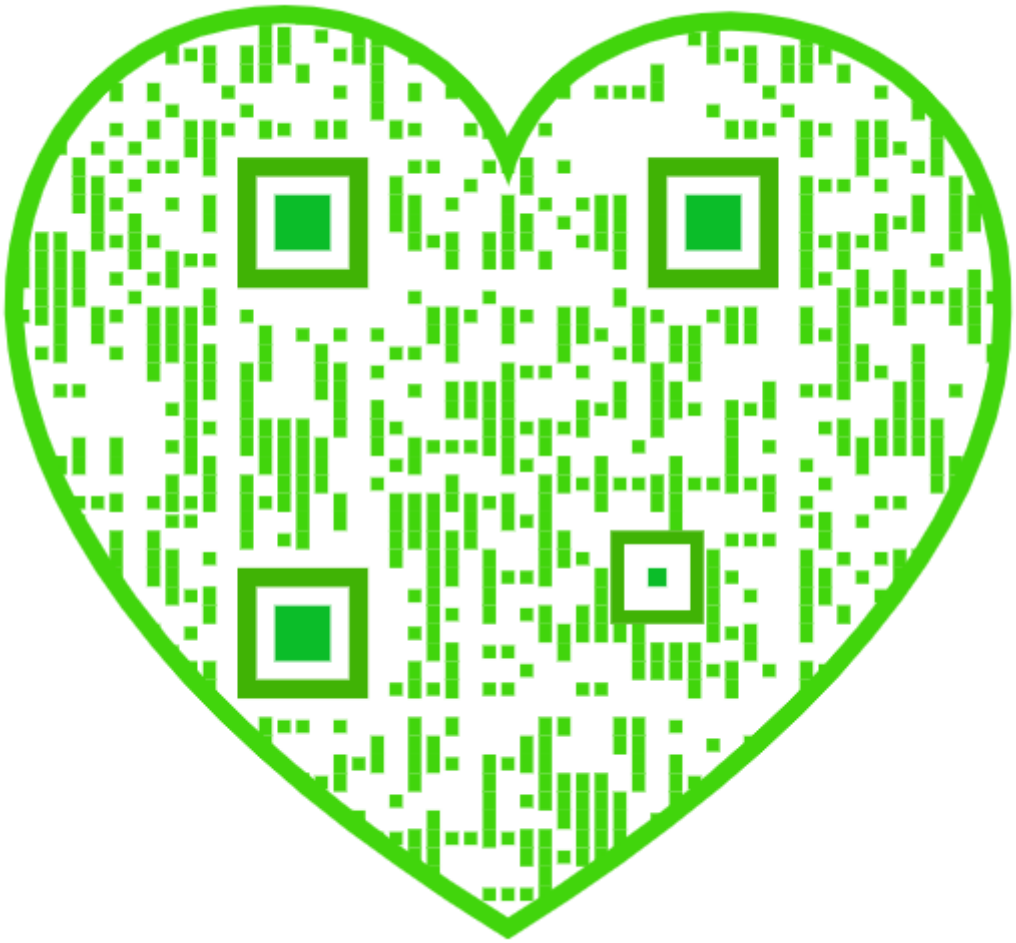

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Fish Culture Compared in Importance with Agriculture.

SPEECH

OF

HON. ROBERT B. ROOSEVELT,

OF NEW YORK,

IN THE HOUSE OF REPRESENTATIVES,

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FISH CULTURE.

Mr. ROOSEVELT. Mr. Speaker, the art of cultivating fish by artificial means is no new thing, it is not an untried theory, resting more in hope than in experience, but has passed from the realm of experiment into absolute certainty. It has become a fixed art, and, although as yet scarcely developed, has grown into a business of considerable magnitude and great importance. Persons unacquainted with the matter have little idea of the discoveries which have been made and the wonderful successes of those who have devoted themselves to the study and investigation of this subject, and do not appreciate the extent of the influence which it is certain to exercise on the future of this country, a country that is wonderfully blessed in this particular as in all others, and is adapted to fish culture to a degree that exists nowhere else.

The older nations had a vague notion of this industry. In China it has been carried on for centuries, as well ages ago as it is now, like most of the discoveries of that unprogressive people. The Romans were scarcely so well informed, and only developed the natural method; and the first real attempts which produced practical results were made in France in quite modern times, when the discoveries of the past were discovered over again. In that scientific and cultivated nation, however, the matter attracted immediate attention, and its importance was appreciated by a people which has long been forced to make the most of its food resources. The Government took it in hand, and, soon satisfied of its practicability, built the national establishment at Arcachon. At first blunders, of course, were made. Finding uncertainty, an uncertainty arising solely from ignorance, in impregnating and hatching the artificially impregnated eggs, resort was had to collect the ova from the various streams of the country, after it had been deposited there, in the natural method, and developing it under proper supervision and guarded from enemies and disease. Directions were at the same time published for stripping the parent fish of their eggs, so that the ripe spawn might also be saved from any mature individuals which should happen to be caught.

This plan, however, was unsatisfactory; it was but little more than robbing Peter to pay Paul. Not only was much unripe and worthless spawn taken through ignorance or cupidity, but the natural supply was carried from the streams to such an extent that they were greatly denuded, and were run down to a degree which was hardly made good by the supplies of young fry which were afterward sent to them from the national establishment. These errors were, however, corrected in time; greater knowledge and skill were attained, better methods and machinery were invented, and in the end Arcachon became a success, fish-culture triumphed over the obstacles in its way, and many of the waters of France which had been entirely depleted were replenished, and the fisheries were restored to a condition of fruitfulness which they had not known for

years, while a most important article of diet was furnished to the people at cheaper rates and in more abundant quantities. Up to this time deterioration and increasing scarcity had been the rule, but soon an improvement began which has far more than repaid the expense incurred by the Government, and has led to consequences the public value of which cannot be overestimated.

England was not long in following the example of France. The salmon fishery has been the principal estuary and fresh-water fishery of Great Britain, and it also had been injured by mismanagement and neglect and overwork. Salmon had long been far beyond the reach of all but the wealthier classes, and even they were beginning to experience trouble to obtain as much as they needed at reasonable rates. Streams which had yielded abundantly within the memory of man were comparatively unproductive, and in some instances were absolutely bare of fish. The Irish and Scotch fisheries were not so badly off as those of England, but even they were reduced far below what they had been. Steps were taken to replenish these, partly by private action, partly by public. Parliament appointed boards of fish conservators and an inspector of salmon fisheries and paid liberal salaries, and passed wise laws for the protection of the young and the spawning fish. The consequences were the same as they had been in France, and soon fish became more plenty; the salmon fishery in one river having more than doubled in actual rental in a few years, while the yield was proportionally increased. Germany, Austria, Russia, all followed the example; all made this a national enterprise and found it to their interest to pay liberally to restock their waters with a means of supplying food to the people which had been so nearly annihilated. In all, establishments for the artifical propagation of the most valuable varieties are established at various points, and yearly furnish most gratifying evidences of the industrial value of this, which promises to be the most widely beneficial of all the discoveries of modern times; for if it is true that that man is a public benefactor who has made two blades of grass grow where one grew before, much more so is he who has restored to the people a food supply which had almost ceased to exist, and the extinction of which was looked upon as the necessary consequence of the increase of population, it being expected to expire precisely when it was most needed.

Such is a cursory statement of what has been done abroad. It alone would justify the United States in following the example of the older nations, and taking this matter under national protection. It is essentially a national matter; the States alone cannot take charge of it and manage it efficiently; they cannot even pass laws which will thoroughly protect the fish at seasons when they should not be disturbed. Rivers run through different States, or are the boundaries between them, and the laws made for part or for one shore might not be identical with those made for other places. Unity of action is essential, for it is useless to protect in one locality if wanton destruction is permitted in another.

Many species are migratory; that is, pass from the ocean at certain seasons of the year after they have grown fat feeding there during their period of rest, up the streams into the fresh water, where alone can they deposit their eggs and hatch their young. In these cases the fishermen along the coast are jealous of those on the upper waters; the former complain that the latter destroy the parents while they are spawning, and in this way destroy the race; while the latter complain that the coast fishermen use improper and murderous methods of fishing, and kill out the entire supply before they can have a chance to reach their spawning beds. Unfortunately, both these complaints are too well founded. Each class takes all it can, blind to the future, which presses closer and closer on the heels of such want of foresight; it looks only to immediate gratification, and accepts the proverb, "after me a famine."

The navigable streams of this country are subject to the jurisdiction of the national Government, and this is even more clearly the case with the coast line within three miles of the shore. This is a general rule of law, and if there are any exceptions to it they do not exist in the western States, where the rivers were expressly reserved to the nation. It is not necessary for the purposes of this application to maintain so broad a proposition, as it

is not intended to take any actual control of legislation on this subject at present, but only to develop the natural resources by artificial means, restock waters which have been exhausted, spread information concerning the matter, and lead the people either to protecting their own rivers or to granting unquestionable authority to Congress to do so. And it is to that alone which the proposed law addresses itself.

The progress made abroad has been stated, and it has been shown to be sufficiently encouraging to induce our country to follow the example, but the cases are different in many points, and in every point to the advantage of the United States. The extent of our inland waters is something that is hardly understood abroad, and is not properly appreciated at home. Our vast lakes, enormous rivers, innumerable streams, brooks, ponds, bays, lagoons, creeks, and rivulets, are not equaled in any other quarter of the globe. In the State of New York alone we have far more area of water than in Great Britain and France united, the actual acreage being 466,457 acres, while entire foreign States might be almost swallowed up in several of our larger lakes. Our rivers run a distance equal to one fifth of the circumference of the globe, and are navigable thousands of miles above their mouths. But more important than all this is the character of our fish, for we have the finest fish in the world for artificial cultivation, the most prolific, the easiest managed, and the most remunerative. This is a superiority more important than the other matters, and in this Nature has been wonderfully kind to us.

In order to explain this difference I shall have to describe with some detail the method of manipulating the parents and raising the young under the artificial method. Fish are exceedingly prolific; nature seems to have made them the great store-house of food which was to be held in reserve until an increasing population should have required it for support. Every need of the human kind seems to be met as it is developed, and the earth apparently holds in its recesses the secrets which are to keep the world thriving and progressing for ages, and until it shall be covered with a swarming and happy population, denser than is now imagined to be possible, or than learned essayists on a subject they do not comprehend would permit as at all prudent. Fish food is manifestly one of the means which are to make such a result possible, and intellectual care is to develop this resource to a degree as yet hardly dreamed of by the most enthusiastic.

Different species of fish, however, vary remarkably in the extent of their fecundity. A cod and a herring each deposit a million eggs, so that a dozen females of either, were all their eggs to hatch and attain maturity, would furnish the entire yield of the present time. Twelve million cod is an incredible number, and unless nature had provided a means of reducing this fecundity the ocean would long ago have been filled, till there would have been more fish than water, and the sea would have been foul with their decaying bodies. There is, however, no danger of any such state of affairs; the difficulty at present lies in the other direction. These are the most prolific species, but the others do not come so far behind, shad producing from ten to twenty thousand eggs to each pound of their weight, and consequently yielding from thirty thousand to one hundred thousand eggs each. Salmon and trout are not so productive, having only about two thousand eggs to each pound, and not even that in the largest. We have not yet learned to breed cod or herring, but we can breed shad, and hence we have an advantage over the European nations that is precisely proportionate to the relation that two bears to twenty. Here is an immense point gained, for shad grow as rapidly or nearly as rapidly as salmon and far more so than trout, and they are as delicious a fish on the table if not quite so substantial a meal.

Nor is this all. Salmon and trout require three months or thereabouts to hatch, while shad hatch within a week. The former must be carefully watched and have special appliances in the matter of water and location; the latter need no attention, and hatch in a common box with a wire grating fastened over the bottom. Salmon and trout are helpless for thirty days after they are born, being weighed down with what is called the umbilical sack, the unabsorbed portion of the egg. Shad are able to take care of themselves and seek their

own food the moment they burst the shell. The former must be fed when young and protected from their enemies for months, salmon not leaving the fresh water and descending to the sea usually till a year or more after birth, whereas the little shad seek the ocean as soon as they are turned loose, and need no care or food till they come back grown fish ready for the gridiron or the baking-pan.

To explain these differences fully, and to show also what can be done even with the least prolific fish, it will be necessary to describe the mode of raising the young by hand as it were, for it is not intended to confine the national operations of fish culture to shad by any means, or to exclude the nobler and more valuable if more troublesome salmon. There are three great classes of fish as viewed from the stand-point of the fish-culturist, each having a different mode of laying its eggs and raising its young. First, the salmon tribe, what ichthyologists call the *salmonidæ*, which deposit their eggs in fresh cold water, digging nests for them and covering them up as fast as they are impregnated by the male; secondly, the herring family, which includes the shad, another migratory species, but whose eggs are left uncovered to drift in comparatively still fresh water; and, thirdly, the perch family, which includes the black bass, which deposit their eggs in a mass kept together by a mucous or gelatenous substance which is exuded with them. The latter cannot be hatched artificially, the mode of manipulating either fish or spawn not having been discovered, and it is only with the first two classes that the fish-culturist has anything to do at present, and these differ wholly in their methods of incubation, if that word can be used in default of a better.

The female salmon digs out a hollow with her nose and tail in the bottom of some cold stream, near its head-waters, and where the current has a gentle and regular flow. She brushes away the dirt and sand with her fins and leaves a bottom of broken stones the size of a bantam's egg. All this while her accepted mate, who has won her favor possibly after many a tough battle with rival suitors, watches near at hand to drive off interlopers. As soon as she has prepared the nest to her satisfaction and the first throes of egg birth come upon her the male darts to her side, presses close against her, often seizing her by the gills and exudes the fertilizing fluid with his body in contact with hers, so that the eggs receive it the moment they issue. This act over and the male retires for a time to resume his watch, calmly devouring any stray eggs which come in his way or have been carried off by the current, while the female proceeds to cover those which have been impregnated. To do this she brings stones with her fins carefully and places them so as to protect but not injure her precious deposit. She is aided by the fact that salmon eggs are almost as heavy as shot and have the faculty of sticking for almost half an hour to whatever they touch when they are first exuded, although they afterward become free. So they sink at once and adhere to the bottom long enough for her to cover them before they are washed away. As soon as the first deposit is properly covered, the operation of spawning is renewed, and so on perhaps for several days, till quite a mound of small stones is erected on the spot where the fishy labors have been expended. Then the parents, weary, exhausted, ugly, ungainly, almost dead, descend slowly to the sea, sickly in themselves and worthless as food until fine living on fat crustaceans and lively minnows shall have restored their flesh, strength, and beauty. At this season they are utterly unfit for food, and those who eat them often eat maggots as well, and the ignorant epicures who put on their tables these fish in December have the satisfaction of knowing that they are eating salmon flavored with worms, and very poor and thin at that.

But no sooner has that pair of spawners left their nest than another pair comes along, and here begins the first difficulty in piscatorial housekeeping, for the second pair are exceedingly apt to select for their operations the identical spot chosen by the first, not only destroying the nest utterly but devouring with apparent gusto all the eggs which were so carefully housed. By instinct the most favorable spots, as where a brook comes in, or a spring bubbles up from the bottom, are first chosen, and these will be dug over half a dozen times, perhaps, before the last pair

visits it and secures it for their young. Nevertheless, the perils of the embryotic state are not over by any means, for all creatures that live on or in the water seem to be fond of fish-roe. Eels wriggle about it, ducks poke their bills among the stones to reach it, little shiners and minnows devour it, and water-bugs of many varieties live on it. Nor is that all; sediment settles on it, silt washes over and smothers it, and fungus grows on it. It must be free to a steady flow of water or it will perish, and one bad egg will contribute the contagion to a dozen healthy ones.

The wonder is not that fish are so scarce, but that there are any at all. Still, some of it hatches, and what have we now? A poor, miserable little fish, half an inch long, left to his own resources in the world to get his breakfast, dinner, and tea as best he can; and not only that, but actually loaded down with a big bag like an extra belly, which he must carry about with him and which impedes his every motion for thirty days. No wonder he hides his head under the stones and falls an easy prey to enemies too numerous to mention. Suppose he makes his way to shallow water, and there near the shore he hides till he has gathered strength and activity. He has to wait from six to eighteen months before he can venture to the sea, for were the fry in their then condition placed in salt water they would perish at once. The eggs are laid in November or December, and the fry appear in January, February, or March, according to the temperature of the water—the warmer the water, the quicker the young hatch, but the more slowly they are developed the stronger they are supposed to be, their period of gestation varying from seventy-five to one hundred and twenty days. Next fall about one half of them will change their appearance and become covered with visible scales. They are then technically called smolts, and the scales, smolt scales, and then they are ready to descend to the sea. The residue will not undergo their change till a year later, when they also will seek a new life. When they have attained this age they are, comparatively speaking, safe, and are pretty sure to return the following spring as grilse, which is the sporting name of a salmon that has not spawned, and will weigh from two to six pounds, and be as beautiful fish as ever gladdened the heart of sportsman or stomach of epicure. After spawning they will again go to the sea and once more return the ensuing year the magnificent salmon of from six to twelve pounds, and thereafter gain every season nearly half a dozen pounds till they come to kick the beam at seventy or eighty, having attained an age that is a mere matter of conjecture.

Salmon invariably return to the river where they were bred. This has been conclusively proved by many interesting experiments, one alone of which need be mentioned. The second back fin, the small adipose dorsal as it is termed, has been cut off before they were allowed to descend the river, and while they were shut up in some fresh-water pond. Grilse and salmon were afterward taken in the same stream without this fin. This habit seems to rule with all fish of an anadromous disposition, and although there was a doubt whether it held good with shad, that doubt has been removed, and it is now established that not only will these return to the place where they first saw life, but to the particular spot, rarely stopping short, or ascending higher, even, than that locality.

It is perfectly apparent, from this short explanation, that the ova incur innumerable risks and are far more than decimated before they hatch. The only wonder is that any live, and it has been estimated that not one in five hundred comes to maturity. With this explanation it ceases to be a matter of surprise that nature has given this class of creatures such wonderful recuperative power; were it otherwise the race would die out in the face of so many difficulties and enemies. But at the same time the slightest thought will show how enormously this fecundity can be made to work in the interest of man, and what a ready means is here offered for the increase of food for the human race. Care can remove these dangers and drive away or exterminate these enemies, and turn this fertility to full advantage; and the method of doing so I will proceed briefly to explain.

The salmon, when they ascend the river to spawn, are shut in some suitable part of the water, being either inveigled there as a favorable spawning-ground or caught in nets and forcibly put there; and when they are fully ready, when they are ripe, as it is termed; that is, when the eggs lie perfectly loose and free in the stomach, they are taken from the water, held over a tin pan, and forced to extrude the spawn and milt by gentle pressure on their sides with the hand. And in this operation a wonderful advance has been made within the last year. Heretofore it was the custom to fill the pans with the water, as this was supposed to most nearly resemble the natural method; but now little or no water is used, it being found that water drowns the spermatozoa or life principle of the milt. This change of practice alone has made a difference of fully twenty per cent. of the yield, as it is found that the impregnation is far more certain by this plan. Care must be taken, however, that the fish are entirely ripe, and that the eggs will run out under a slight pressure; if they will not the fish is returned to the water till it is in proper condition.

The eggs are left for half an hour undisturbed, and then are washed and spread in troughs which are filled to the depth of an inch with clean pebbles, and through which flows a gentle current of filtered spring water, and there they remain away from fowls and fish and bugs, safe from sediment and fungus till they hatch. They only require occasional examination for the purpose of preventing the collection of deleterious matter, and to remove such as may die and endanger the others. When they hatch they are left in the troughs till the umbilical sack is absorbed, when they are placed in ponds and fed on beef liver finely grated. Under this management all the serious perils of the natural method are averted and the difference in the result is almost incredible, being little less than as a thousand to one.

These directions apply to all the salmon tribe—the salmon, the trout, the salmon-trout and the white-fish, all of which have the same peculiarities. To explain the process more fully, I will quote from the report of the New York commissioners of fisheries, presented to the Legislature of that State March 19, 1872:

"*State Hatching-House.*—By the last amendment to the act of the Legislature, concerning the protection of fish in this State, the commissioners of fisheries were authorized to build a State hatching establishment for the purpose of breeding the better kinds of fish for distribution throughout the waters of the State. This building was erected during the summer of 1870, and was completed in time for use in the artificial incubation of salmon-trout and white-fish. It is neither a very large nor a very costly establishment, but is the most efficient, practically, and the most productive in results of any in the world. The water is introduced in the ordinary way, through a number of flannel sieves, and is led into twenty-four troughs, which are sixteen feet in length by fifteen inches in the clear in width. These troughs are raised about two feet from the ground, so that a person sitting on a stool alongside of them can readily examine the condition of the ova during the period when they are hatching. The lower end of the trough is an inch lower than the upper end, so as to give a gentle motion to the waters which are introduced into them. The water flows from a spigot about an inch in diameter, and through another flannel screen, which is an additional protection against the accumulation of sediment.

"The troughs stand in pairs, so that the workmen can readily overlook them by passing on each side through a passageway left for that purpose. They are divided up into compartments at every two feet, and at first, when the eggs are being hatched, the water running through them is only about half an inch deep. The moment, however, the fish are out of the egg, screens are introduced at each compartment, and a piece of board being put across the lower end of the trough the water is raised to about three inches in depth.

"The State hatching-house has been greatly enlarged the past season, and operations for the winter hatching of fish have been, on an unprecedented scale, commenced. Millions of the spawn of salmon-trout were taken there from the great lakes to be distributed through the State, or to be developed and then distributed. It is much easier and less expensive to distribute the ova than the young fishes. The ova may be transported anywhere during the month of December, but no later. More attention than heretofore has been paid to the cultivation of salmon-trout, and less to that of white-fish, for it was found that objection was made to the introduction of white-fish in many of our ponds, on the ground that they have to be caught with a net, and that while they are being taken, many other fish which could be caught with a hook and line are destroyed at the same time. With salmon-trout this is altogether different; and as they bite readily at a hook, are a handsome game fish, and good for the table, it is proposed hereafter to raise a far greater portion of them, and few, if any, white-fish.

"A full detailed account of these operations is appended, and the commissioners pride themselves upon not only building the cheapest and largest fish-breeding establishment in this country or in the world, but also in building one that has in every way proved an entire success, and which is capable of supplying all the public waters in this State with all the salmon tribes of fish."

So much for salmon. Now for shad; and it is rather remarkable that the whole process is dissimilar, so much so that it had actually to be discovered over again. So entirely different are the two processes that I cannot do better than describe the manner in which the latter mode was discovered. The credit of this is due to our country, and to Mr. Seth Green, of Rochester, New York, who is the ablest pisciculturist to-day in the world, and whose name will hereafter be written in the list of those who have deserved well of the Republic. He offered his services to the New England commissioners, and proceeding to the Connecticut river set about his operations in May, 1857. He had little difficulty in catching ripe fish and none in extracting the spawn, to which he was accustomed from handling trout, although he afterward ascertained that the true time to take the parents was at night, from eight to twelve p. m., as they seek the spawning-beds principally during the dark, but he soon found other and more serious troubles. He naturally pursued the same method he had followed with trout, placing the impregnated eggs in a trough and turning on a gentle current of water. What was his surprise, however, when he saw all the eggs wash out over the lower end of his trough. Here was the first striking difference, whereas trout eggs are almost as heavy as shot. The ova of shad have little more specific gravity than water, and will nearly float of themselves. Then he reduced the current and the eggs all died. This was failure number one. He next tried leaving them in a pool near shore, where there was no change of water, and found the eggs all opaque and lifeless next morning—failure number two. He then built a low dam of small stones so as to make a pond in the course of the current, and so that the water would find its way through the crevices, but still only a trifling quantity hatched—failure number three. He next tried boxes, putting wire sieving over the ends and the bottoms and the sides, but in vain, till he was almost in despair, and the season had nearly reached its close. Then fortune favored him. He happened to be standing in the water experimenting with a box that had the wire sieving on the bottom, and which was filled with eggs, and accidentally elevated the front end so that the current struck the bottom at an angle. He observed that some of the eggs lying in the lower end were lifted and kept in motion like the bubbles boiling up in a tea-kettle; he elevated the further end a little and more eggs boiled up; he raised it still further and they all commenced boiling madly, although the water did not pass over the top of the box at the lower end. The question was solved, and thereafter shad hatching was a certainty and a success, and no ordinary success either, for while of trout and salmon nearly ten per cent. are lost even now with dry impregnation, with shad the loss is so trivial that, practically speaking, absolutely all are hatched.

Mr. Green felt jubilant, but he was by no means out of the woods. He soon had his boxes filled with young, for instead of taking months, like salmon, shad issue from the egg in a few days, and he proceeded to dispose of them as he would do with trout. The latter, as soon as they can swim, seek the shore to hide under grass, weeds, and stones, but when the shad were set free in the shallow water all the shiners, dace, minnows, killcys, and other small fish in the entire neighborhood collected as though they were invited to a feast, and proceeded to devour them in a way that was exceedingly painful to a parent's eye. Here was a second perplexity, and there was nothing for it but to wait for an explanation or an inspiration. So a pond was built on the side of the river, and the youthful adventurers left there till some one should find out what to do with them. Next morning they had apparently all disappeared, and were finally found huddled together at the outer edge of the pool. Here was a suggestion, and to test its significance another pond was made, narrow, but running far out into the stream, and into this the fry were transferred. Next morning they were again discovered collected at its outward

extremity, evidently trying to reach the center of the river, and that problem was solved.

Now, the moment the shad are hatched, the boxes are towed out into mid-stream, and there, away from the small but dangerous foes along shore, and too minute to attract the bigger denizens of the deep water, the little fish are turned loose to find their own way to the ocean, which they do by gradually floating down stream, keeping their heads to the current to catch such food, invisible to man, as may come along, and feebly wagging their tails to acquire strength and activity. In two years the males return weighing something under a pound, and in three years they reappear, males and females, the magnificent fish, from two to five pounds, that are so welcome to our table.

The difference between the natural and artificial method is too great almost to appreciate. Take the case of a shad depositing by the natural method sixty thousand eggs. Of these, at the utmost, one hundred and twenty hatch, and this is probably the outside limit. Of this number say one quarter mature, the proportion in this stage being a mere matter of conjecture, and we have a final return of thirty for two or fifteen for one.

Now, by the artificial method the entire sixty thousand are hatched and started in life away from their enemies. Of these, if a quarter reappear, we have fifteen thousand in lieu of thirty. Keep this up at a geometrical ratio and the results are simply incalculable. Rivers that are now deserted could be filled to repletion, so that there would be abundance for netters, seiners, and fishermen of all kinds, whether they fished in season or out of season, early or late, and with murderous or legitimate implements. This is the object to be obtained, and although at first it may be desirable to have protective laws till the propagating-houses are established and in working, in the end they should be all swept away and the people allowed to pursue, catch, and eat whenever they might feel so inclined. No river on our continent yields more than a million shad annually; so that with a moderate effort the supply could be immensely augmented; but the effort should not be suspended until at least one hundred million young fry are placed alive in every stream of considerable size at present visited by these fine fish.

The vast superiority of shad raising over salmon raising is perceived in a moment by a comparison of the two systems. The former requires merely a few hundred boxes of common wood, with wire sieving over the bottom, covered with coal-tar to protect it from the action of the water. These boxes have pieces of wood nailed on their sides to act as floats, and at such an angle as to keep the bottom slightly inclined against the current, the degree of inclination being regulated by experiment. The boxes are strung behind one another in long lines, their floats projecting beyond the ends, and connected with ropes. The whole swings with the tide if in a tide-way, or tails out under the influence of the current, and needs no care except at slack-water, when they need jogging now and then to keep the eggs from being smothered. The expense of all this is so trifling as hardly to be worth mentioning, while the product is immense.

The spawning-grounds are always near fishing-stations, and the fishermen can readily be induced to haul at night by a little extra remuneration, as they use the fish whether stripped or not. As soon as the net is hauled ashore and the fish thrown into a boat a pan half full of water—for dry impregnation has not yet been tried, although it will probably be universal in time—is placed near the operator, to whom the fish are handed one after the other. He manipulates them, throwing them aside as fast as they are stripped, and when they have all been used he sets the pans aside for half an hour, during which time the eggs swell and become firm and turgid and the water falls ten degrees in temperature. This is repeated as often as the nets are hauled, and finally the pans are taken to the boxes and emptied into the latter, where the eggs remain till they hatch, the period varying according to the heat of the water from two days to seven. Nothing can be simpler than all this, and though, like everything else, it requires a little practice, the roughest and most ignorant man can soon acquire the requisite knowledge to manage the establishment.

The great results which are promised by this enterprise are not mere matters of guess-work;

salmon have been cultivated abroad so as to restock abundantly many streams which had been entirely depleted, and here the consequences of shad culture have proved themselves to be exactly what it was predicted they would be. The same fall that the first experiments were made in the Connecticut, shad fry were noticed as being unusually abundant in the lower part of that river, more so than they had been known to be within the memory of the inhabitants. Three years later they returned—they were not expected sooner, such being their habit—and in numbers surpassing anything that the fishermen had experienced in years. At first this was supposed to be only an accident, and was explained by the unbelievers upon various theories, and these asked a suspension of judgment until the next year. But all theories in opposition were put to rout next season when the fishing was actually unprecedented, being better than had been known in fifty years. So decided was the effect of this improvement that the price of shad fell in the northern markets to less than one third of what it had been previously. And I will in this connection again quote from the report of the New York commissioners:

"Shad were far more abundant and far cheaper than they had been for years, both on the Connecticut and the Hudson; especially so on the former river, the yield from which actually glutted the markets and reduced the wholesale price from eighteen dollars a hundred down to three. This was manifestly the consequence of the previous efforts, and confirmed the predictions of those who had studied the habits of the fish. It was expected that the great body of such as were hatched would return in three or four years full grown; and it was exactly four years previous that Mr. Seth Green, under the auspices of the New England commissioners, had first discovered the method of hatching shad, and had placed many millions of young fry in the Connecticut.

"Most of these returned to the river where they were born. The effect on the market, however, was mainly attributable to the yield of that river, which supplied New York and other adjacent cities so abundantly as seriously to reduce the profits of the fishermen on the Hudson. It is perfectly plain, from these results, that unless active steps are taken to restore our fisheries, and unless we keep pace in this matter with our eastern neighbors, our fishermen will be entirely ruined. So entirely are the latter satisfied of this, that there is no difficulty in obtaining their consent to any measures that will tend toward accomplishing this end. The experiences of last season convinced the most incredulous, and they are now as anxious to encourage fish culture as they were once bitterly prejudiced against it."

When a process to add to the wealth and resources of the nation is so simple and yet so valuable, it would be criminal in the Government to refuse to lend a helping hand, as, for the reasons already given, this can never be a matter of private enterprise or even of State industry. Trout can be preserved in private ponds, and should be, as they are, left to professional fish culturists to produce, and these drive quite a trade and make large profits, there being many hundreds of thousands of dollars invested in the business; but no one individual can retain any ownership over a fish which must go to the sea, nor can even any single State, except in the rare case of the river being entirely within its own jurisdiction. We have established a National Bureau of Agriculture on a large and expensive scale. Why should there not be a similar institution for pisciculture? At least we can take a step in that direction, and begin on so small a scale as is proposed by this provision of law.

The relative fertility of the water and the land is altogether in favor of the water. An acre of land will produce corn enough to support a human being, but an acre of water will support several persons, and could readily be made, with proper aid, to sustain the lives of many more. The former requires manuring, working, planting, and harvesting; the latter merely requires harvesting; and that where the fish are sufficiently abundant is hardly a labor at all. While the yield from the land is reasonably large, the profit is exceedingly small. The field must be plowed, and harrowed, and fertilized; the corn must be planted; it must be plowed again; and still again, must be hoed; and at last the ears must be stripped, husked, and ground. What is the net result of this compared with the natural increase of fish grown in abundance, almost without effort, finding their own food, and finally taken in some net which does its fishing while its owner is sleeping?

Then the relative productiveness: the ear of corn grown from a single kernel will more frequently fall below than rise above a thousand grains. A shad lays, say sixty thousand

eggs, of which we have said fifteen thousand can be brought to maturity with the care and oversight of man. Were the farmer to strew his corn broadcast over sod and rock alike, "by the wayside and on the stony places," and leave it to come up with weeds and tares without manure or attention, he would hardly expect a good crop, and would find much trouble in living on the proceeds, no matter how much land he owned, and yet this is precisely what we do with fish. To judge by what has been effected it may be confidently asserted that fish culture is yet to add a very large proportion to the wealth and resources of the world, above all to the riches of this continent. At present our vast lakes are left untilled, some of the smaller ponds and many streams in the older and more thickly settled States have absolutely no edible fish in them, and some no fish whatever; the hook, the net, the spear and the "jack"—night-spearing—has annihilated the last one. They teemed once with their natural inhabitants. Why cannot they be made to do so again? The evidence of our own and other countries clearly prove they can.

The decrease of fish is attributed to overfishing and unseasonable fishing, which is true; but these are the ordinary concomitants of advancing civilization and increasing population, and only admonish us that man must use his mind to increase the supply. It has been alleged that the food had diminished even in the sea; and here again I cannot do better than quote from the report before alluded to of the New York commissioners:

"A familiar explanation of the decrease of fish, given by all those who are interested in keeping up the present unwise mode of destruction of the fisheries, is that their food has disappeared. It was essential in the first place to ascertain whether this was true; and to determine the question dredges were drawn over the mussel beds, and the water in various parts of the bays and ocean was examined, to see if it contained much animal life. These examinations demonstrated that instead of any decrease in the supply of food, it must absolutely have increased from reduced consumption and the destruction of its natural enemies; the bivalves, crustacears, and all manner of similar creatures were abundant on the bottom, while the water was literally alive with animal matter, with polyps, infusoria, jelly-fish, &c. A bucketful taken from it anywhere was simply full of such animalcula. Here was one point settled conclusively; true that the menhaden had been used for their oil to an extent that had made them scarce, and their disappearance had injured the more ravenous varieties of fish, but the bottom-feeders and the slow swimmers had around them more food than they could possibly consume."

The truth is the food is too abundant, for these creatures often prey on one another, the smaller varieties devouring the eggs and young of the larger, and becoming, in their turn, a prey to those of maturer growth. And here is the true explanation of the rapid extinction of fisheries when they become depleted beyond a certain limit. Nature balanced the number of each kind, providing that mutual destruction of one another should keep all in check. Man destroys this equipoise by killing those only that he can use. The rest then augment at an increased ratio, the enemies of all sorts of the edible kinds have no check, they multiply, and multiply until they obtain the mastery, and then quickly comes the end when the better sorts are exterminated. This is apparent, but is sustained by the fact that new varieties when introduced into unaccustomed waters increase for the first few years with inordinate rapidity. For a time their natural foes do not exist in sufficient numbers to curtail this growth, but as the latter develop the counterbalance is restored and the stimulated activity of reproduction ceases.

The time may come in the distant future when the edible fishes shall be made so abundant by artificial cultivation that the food of the piscivorous sorts may fail; then it may be necessary to breed those which live on water-grasses and vegetables to supply the others with sustenance. At present, however, there is no such necessity; not only is the sea alive with food, but the large lakes are equally well peopled. It is a curious fact that in Lakes Huron and Superior is found the salt water shrimp in the deeper parts, and in quantities equal to that in the ocean. This shrimp, which itself is exceedingly prolific, is the principal food of the true salmon, the *salmo salar*, and is supposed to constitute the red color of the flesh. But if it were requisite the cyprinidae could be cultivated or introduced, or some other variety which lives solely on a vegetable diet, but which of themselves are not good for food.

This will doubtless be done as soon as it is needed, and has already been successfully tried in Europe, so that should the present supply of fish food give out it could be replenished.

The fisheries of our coasts are among the most valuable commercial interests of our country. Millions of money are invested and hundreds of thousands of men are employed, while the food thus obtained is a large percentage of the total supply of the eastern markets. Not only is the profit of this business a matter of general advantage, but the residents along the eastern bays and lagoons and upon the larger rivers derive their principal means of sustenance directly from these waters, and in all these districts far more families are supported by the water than by the land. In the West there is nothing of this sort. The markets are almost bare of fish; a few catfish, suckers, and pickerel constitute the wretched and meager bill of fare they offer. The muddy Mississippi contains little or nothing. The beautiful Ohio has but one or two sorts of pike-perch, which the inhabitants flatteringly call salmon, while catfish hide in most of the discolored streams of our continent and suckers explore the bottom for their food.

If anything can be done to improve this state of affairs, to make fish and fishermen as abundant in the West as they are in New England, and to develop the same activity in this matter that exists in the East, it is well worth the serious consideration of the Government. By this means a new industry, an additional source of income, an entirely different species of food would be introduced, and an immense increase added to the wealth of the whole region of country. There is no reason why the waters of the West should be less prolific than those of the East, provided the right species were introduced; and were trout, salmon, bass, shad, and sturgeon to take the place of catfish, pickerel, and suckers, the gain would be manifest.

It seems to me clearly to be the duty of the Government to assist in this very work of introducing new varieties, as well as replenishing the old where they have been reduced. No private person can own a shad which is here to-day and in mid-ocean to-morrow, nor is a single resident on a river's bank sufficiently interested to incur the expense of importing fish for the benefit of his neighbors. This is the nation's duty or it is nobody's. The mighty rivers of the southern and western States, which now produce generally only the poorer sorts, could readily be stocked with the most palatable and prolific sorts. The shad has already been acclimatized in some of the Alabama rivers, where it never before was known, and the Potomac has been filled with black bass almost to repletion; but that was the unaided effort of individuals as a mere matter of experimental curiosity. Other rivers remain still unimproved, and several foreign species of fish should be introduced. For instance, the magnificent Danube salmon, which attains a weight of a hundred pounds, might be acclimatized in the Ohio and the upper Mississippi, while the true salmon might be brought to the Delaware and Susquehanna. This is perfectly simple and easy. Salmon have been transported while in the embryo state from England to Australia, half way round the globe; our white-fish, trout, and salmon-trout have been sent to England, and living shad were actually transported from the Atlantic to the Pacific, offering the possibility of supplying that entire coast and ocean with a new fish. This latter was a remarkable feat; but trout spawn are sent from one end of our country to the other with as little trouble or danger as letters, and are delivered by express precisely as any other packages. The slow-hatching fish are the more easily handled in this particular, as the eggs develop slowly and will live perfectly well packed in damp moss, but other kinds only require care and experience.

The cost of this undertaking is insignificantly moderate. A salmon-hatching house can be built for $1,000 while the necessary implements for shad raising are too inexpensive to be worth mentioning. Some labor must be employed, but it is mostly unskilled and cheap, while the outlay for transportation is simply the mere charge of express or traveling fare. The people of this country would not grudge this were it a hundred times as great with the certain prospect of developing a new food resource and of diminishing the price of living to the poor.

The importance of this matter can hardly be verestimated. We raise animals for man's se, cross their breeds, study their food, and y and adapt their surroundings to their great- st development. We cultivate plants and egetables, and strive to obtain new species nd improved varieties. We import cattle om Europe, horses from Africa, sheep from pain, wheat from Egypt, sorghum from Asia. ur daily struggle is to make the most of what- ver can be turned to the support of the human ace, except with one great class which has ways contributed, and, unless exterminated, ways will contribute largely to that end. Who would have thought twenty years ago hat a despised "love apple" could ever be onverted into the useful tomato? And in arlier days who would have expected the hange from the poisonous wild potato into he succulent root which now supports a na- on and adds to the comfort of every human eing?

What was done with the common tomatoes, potatoes, onions, and hundreds of other vegetable productions, which, as wild, were worthless, may in a higher degree be carried into effect with fish. Wild rice scarcely produces enough seed to continue the supply; but protected, developed, encouraged, it feeds a tenth part of the world. Fish neglected, destroyed, poached and wasted, can soon be annihilated. Their reproductive power can only maintain a certain equilibrium; incline that toward destruction, and the entire class will quickly disappear. Treat them like wild animals, and they will inevitably be exterminated; domesticate them, as it were, encourage their growth by putting them under heathful influences, protect them from unseasonable disturbance, let them breed in peace, guard the young from injury, assist them by artificial aid, select the best varieties for appropriate waters, and we will soon augment the supply as greatly as we do with either land animals or vegetables.

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